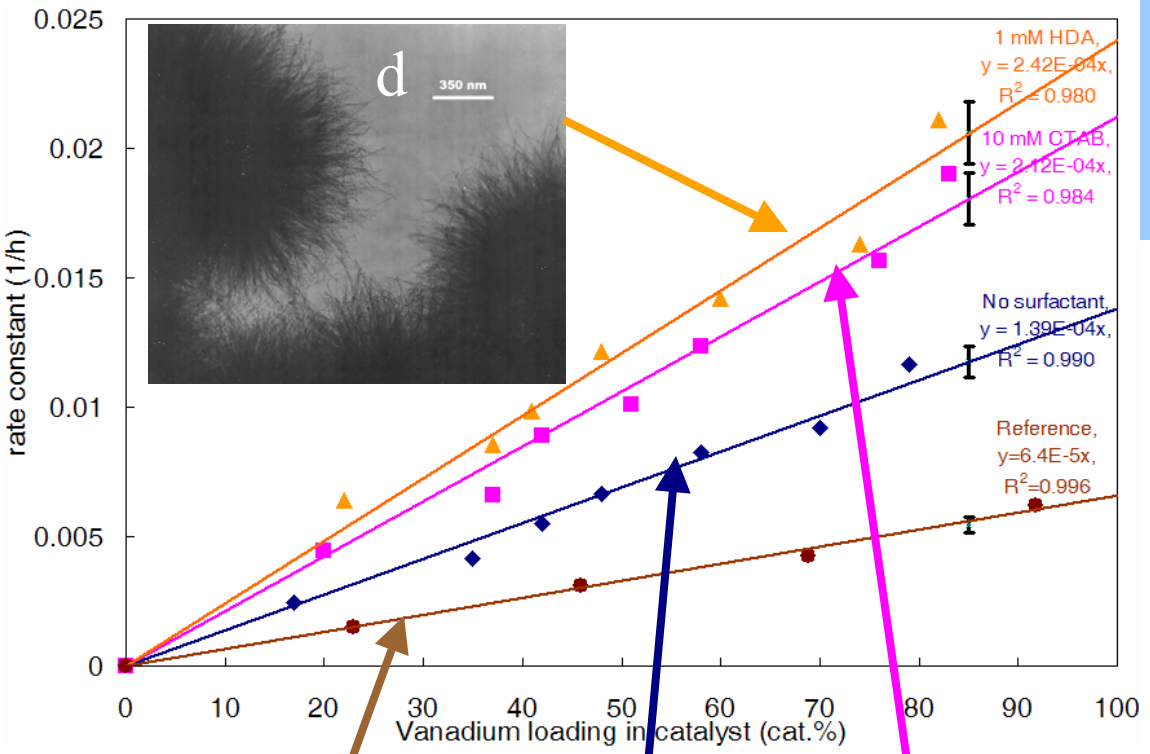
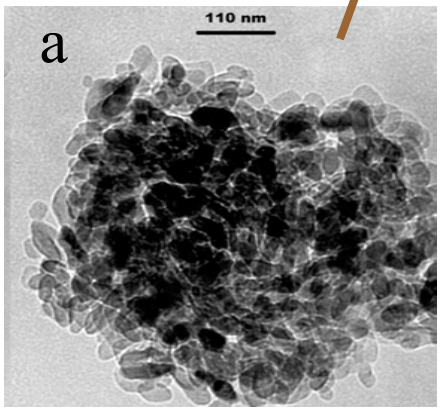
Engineered Ceramic-Organic Interfaces: Properties and Applications

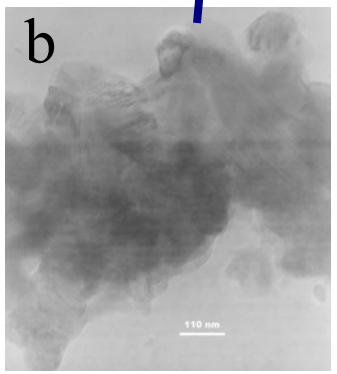
Mark De Guire, Case Western Reserve University, DMR-0203655

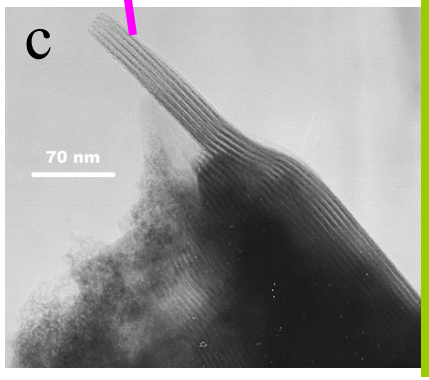
GOAL: The higher the surface area of a catalyst, the better its performance. The present work aimed to design catalysts with high porosity, and therefore surface area, on the nanometer scale.



STRATEGY: Organic surfactants were used to form clusters, called micelles, a few nanometers in size in an aqueous solution. From the solution a vanadium-titanium oxide catalyst formed spontaneously in a single step on the micelles. The micelles were rinsed away, leaving a nanoporous solid that catalyzes the oxidation of lactic acid to pyruvic acid (one of the steps used by living things to convert food to energy).







RESULTS: The catalytic rate constant increased with the vanadium content and the surface area of the resulting powders. Counterclockwise from lower left: a) catalyst made by a conventional process; b) catalyst made by the single-step process, no surfactant; c) nanotubes made using CTAB surfactant; d) nano-"hairballs" made using HDA surfactant.

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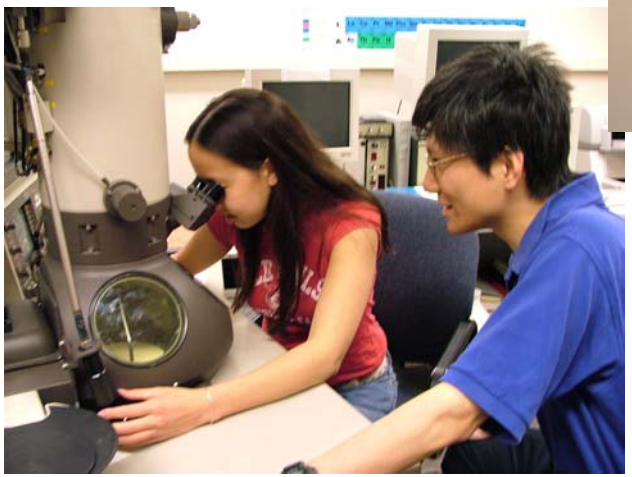
Education & Outreach:

In its first two years of funding, the project has supported the research of four graduate students. Jing-Jong Shyue finished his M.S. in 2003 and his Ph.D. in August 2004. Yin Tang received her Ph.D. in August 2004. Lijun Zou received her M.S. in 2003 and is pursuing doctoral work at University of Rochester. Matthew Croyle is pursuing his M.S. degree while employed as a full-time engineer at Sherwin-Williams Co.

Maria Salamon did her senior project with the group, and entered graduate school in Materials Science at Case in August 2004.

Emma Chan, a senior at Cleveland Heights High School, spent two weeks with the group in May 2004 getting hands-on experience in materials science, her intended major in at the University of Michigan.

Above and right: Emma and Yin synthesize and test a tin oxide sol gel.



Left: Emma and Jing-Jong view nanocrystalline catalysts in the transmission electron microscope.